Section 1.03 LIGHTING

An effective way of accommodating more tennis play is to include lighting in plans for new courts or to light existing ones. Lighted outdoor courts can provide additional hours of prime time each day. Lights can make tennis possible for many working people who, with limited daylight free time, have difficulty in gaining access to busy courts. In some regions, daytime conditions can be uncomfortable (heat, glare, wind) and play in the quiet cool of the evening is very desirable.

The prime object of proper lighting is to provide good visibility of the ball along every possible path while in play. The lighting design should minimize glare for players and possible spectators, and should minimize glare and stray light in the surrounding neighbourhood.

In selecting and designing an outdoor lighting system, factors which must be given consideration include:

1) desired level of light
2) type of luminaires
3) placement (location and mounting heights)
4) annual operating hours
5) cost (including initial, energy, and maintenance costs)
6) environmental concerns - light pollution, unwelcome illumination

An electrical engineer with knowledge of and experience in lighting tennis courts should be consulted to design an appropriate lighting system.

Characteristics of the Light Source

There are three possible types of light sources for lighting outdoor tennis courts. These are the **high intensity discharge (HID)** lights consisting of mercury vapour, metal halide, and high pressure sodium light sources, **incandescent** (including quartz or tungsten halogen) and **fluorescent.** In essence, each of these sources produces light from a different substance and as a consequence, each light has its own unique characteristics.

Before characterizing the various sources of light, it is necessary to define the properties so as to have a background from which to compare various light sources. The Illuminating Engineering Society (IES) has the following categories in its ratings of lamps: lumen output per lamp, efficacy, life expectancy, colour acceptability, degree of light control, and maintenance of lumen output.

1. Lumen output: refers to the amount of illumination that one lamp can give. This rating determines how many lamps are needed to provide the desired number of footcandles. (A footcandle is a standard unit of measuring illumination levels; lux is the metric equivalent and is calculated by multiplying footcandles by 10.76.)

2. Efficacy: is a measure of how efficiently the light source uses power, of how many watts the light source requires to give off a certain amount of illumination.
3. Life Expectancy: is the number of hours a lamp will function.
4. Colour acceptability: is the ability of a lamp to render the objects it lights in a natural tone.
5. Light Control: is the degree to which the light source can be aimed and controlled by a luminaire.
6. Maintained light level: is the ratio of the depreciated amount of light (generally after 100 hours of lamp usage) to the initial light level. This ratio generally ranges from 6/10 to 8/10.

High Intensity Discharge Lighting

This category of lighting for tennis courts uses high intensity discharge lamps (HIDs). These include mercury, metal halide, and high pressure sodium lamps and although each of these has its own characteristics, the group shares several properties.

HID light sources, for the most part, have a long lamp life and high efficacy when compared to incandescent lamps. They also have a characteristically slow power build-up when first energized, which results in a delay of up to 7 minutes before they achieve maximum brightness.

If there is a power interruption, HID lamps require a restrike time of 1-3 minutes for high pressure sodium, 3-6 minutes for mercury, and 10-15 minutes for metal halide lamps. This is important when considering installing metres or switches at each court.

The lumen output of the HID lamp decreases during the first 100 hours of operation, a "seasoning" period which allows a clean-up of impurities to take place. After this period, the light output stabilizes and its decline becomes much more gradual.

1. Mercury lamps which tend to give off a blue-white light, are not as desirable as that of other types but can be improved by using phosphor-coated bulbs.
2. Compared to incandescent lamps mercury lamps do produce more than twice the light for the same wattage (about 60 lumens per watt), making them much more efficient as a light source.
3. Mercury lamps are rated at 24,000 hours of lamp life. While this may be an advantage for courts that operate for a great many hours each year, such a long lamp life would not be necessary for a facility that uses lights only 400 hours per year.
4. As with incandescent lamps, mercury lamps can be operated above the rated wattage, thereby increasing the light output but shortening the lamp life.
5. Metal halide lamps are mercury lamps with the addition of metal in the form of halide salts. This light source has a higher efficacy rating with better colour rendition and good light control. At 10,000 hours, its lamp life is significantly shorter, than that of the mercury lamp. Because of a higher lumen output, however, fewer metal halide fixtures would be required than mercury ones to achieve the same footcandle level.

6. High pressure sodium lamps have the highest efficacy rating and 30 percent more lumen per watt output than metal halide lights. Both lumen maintenance and light control are also good, and the lamp life is rated at 15,000 hours. The lamp produces a slightly orange or bronze light, which is most noticeable when seen in contrast to another type of light source.

Incandescent Lighting

The main advantages of incandescent lighting are low initial cost, high colour acceptability, and excellent light control. The main disadvantages are short lamp life (about 2,000 hours) and low efficacy (20 lumens per watt).

Unless a facility operates very limited hours, standard incandescent lamps will cost so much to maintain and replace that any savings from their initial installation is likely to be lost. However, the tungsten halogen (or quartz) lamps, which fall into the incandescent category, have both a higher light output and a longer lamp life than standard incandescent lamps.

Another advantage to the incandescent to tungsten halogen lights is their smaller size, which results in smaller and lighter luminaires (lighting fixtures). This may reflect in lighter poles for mounting.

One way to improve the efficiency of incandescent lamps is to operate them at over voltage: in excess of the one they are normally rated to take. The IES sports lighting guide indicates that operation at 10 percent above the rated voltage will increase the light output by approximately 35 percent (with only a 15 percent increase in lamp wattage), but with a reduction in lamp life. This means of operation is recommended for facilities that will be in operation for less than 200 hours per year.

Operation at 5 percent over voltage will increase light output by approximately 17 percent. This is recommended for lighting installations used from 200-500 per year. If the annual use of lights is above 500 hours, the lights would best be operated at their rated voltage.

Fluorescent Lighting

Fluorescent lamps used in outdoor tennis installations are generally 8 feet long and come in two categories: very high output (VHO) and high output (HO). The very high output lamp has a rated average life of 9,000 hours. It also provides 15,000 initial lumens, approximately 75 lumens per watt, good colour acceptability, and relatively low brightness.

The HO lamp has a rated average life of 12,000 hours and provides 9,200 initial lumens (also approximately 75 lumens per watt). Compared to VHO lamps they are better in their lumen maintenance and equivalent in colour acceptability: they also have a longer life.

The relatively low brightness of fluorescent light sources is advantageous because the mounting heights can be lower without causing undue glare for either players or spectators. The lower mounting height on outdoor courts places this light source closer to the normal line of sight of the players.

Quantity of Light

The quantity of lights is important but must be considered along with other factors.

1. **Class I:** For professional, national and international championships. This lighting design will provide an average maintained level of 125 footcandles (1345 lux).
2. **Class II:** For sectional, state, city, and college championships. This lighting design will supply an average maintained level of 60 footcandles (645 lux).
3. **Class III:** For clubs, instructional, parks, high schools and residential play; minimum level for park and club tournament play. This lighting design will provide an average maintained level of 40 footcandles (430 lux).
4. **Class IV:** For social, parks, and recreational non-tournament play. This lighting design will provide an average maintained level of 30 footcandles (320 lux). Measurement of footcandle levels should be made 36 inches above the court surface. Lighting for the entire playing area surface should be as evenly distributed as possible.

Quality of Light

It is not necessary to produce an enormous number of footcandles (lux) of lighting since the quality of the light is considered to be more important. Quality of light is determined by a number of factors including uniformity of distribution and minimal glare from the light source.

Lighting levels should be as nearly uniform as possible within the primary playing area which includes a few feet outside the sidelines and behind the baselines.

The colour tone of light is important. Quartz and incandescent lamps produce a warm colour and help make the flesh tone of the skin more natural. Fluorescent, metal halide, and colour-corrected mercury vapour lamps produce a cooler colour rendition.

High pressure sodium produces an orange bronze tone which is less satisfactory for tennis play. However, mixing high pressure sodium with metal halide (half and half) gives good colour rendition and a higher level of lighting than metal halide alone.

Glare

Glare exists when the source of light causes eye discomfort and reduction of vision. During the normal course of play, it is caused by relatively small sources of illumination that have high

intensity (great brightness). This is particularly noticeable when the source of light contrasts strongly with dark backgrounds such as the night sky.

Floodlight

Open floodlights will produce wide beam spreads suitable for lighting at close distances; enclosed floodlights can give a variety of spreads both wide and narrow, and are more versatile for this reason. Closed floodlights have the added advantage of maintaining light output better than open floods, which are exposed to the elements and tend to accumulate dirt and debris. Open floodlights have a lower initial cost.

An important consideration when comparing open and closed luminaires is the light loss factor. The IES sports lighting guide suggests that it is accepted practice to allow for a light loss of approximately 25 percent for enclosed floodlights, and of 35 percent for open floodlights when calculating the maintained level of footcandles. In other words, after the initial amount of illumination that the light source will emit has been determined, it must be reduced by the light loss factors given to obtain the actual amount of light that will reach the court.

Enclosed vs. Open Fixtures: Because an enclosed fixture is sealed, it has limited exposure to dust and dirt. As a result, such a fixture, while more expensive initially, will require less maintenance than an open fixture and have less of a light loss. Fluorescent fixtures are by nature large and often open. Because they have more surface, fluorescent fixtures will be more susceptible to the accumulation of dirt and debris.

LED Lighting

Any clubs needing advice on LED lighting (ie: cost savings, key components, energy reduction, product performance, labour/maintenance and utility incentives etc.) please feel free to contact:

Tony Valentini, Lighting Specialist
Gerrie Lighting Solutions
905.681.3656 ext.20180 | tvalentini@gerrie.com
www.gerrie.com

To view the Gerrie Lighting Solutions brochure, please CLICK HERE.

Location of Fixtures

It is extremely desirable to locate all lighting fixtures along the sides of the court (outside the fences) so that the light beams are generally directed across the courts. If side placement is not possible, fixtures should be located to achieve low glare and high uniformity.

As a special item of caution, no light fixtures should be located directly behind the courts or at the corners. Doing so can produce glare for the players caused by their having to look directly towards these fixtures when serving or during normal play. Corner lights if installed should be at least 35 feet high, shielded or aimed to minimize glare for the players on the opposite side.

It is recommended that light poles be located immediately outside fences or between net posts. Any free standing light pole not so located should be heavily padded to protect a player running into this obstruction. A final aiming of high mast lighting systems should be done at the job site with hand held metres to obtain the most even light distribution, however, some systems are pre-aimed by design.

Mounting of Fixtures

New designs in H.I.D. sharp cut-off luminaires have reduced the mounting heights to approximately 20 feet with good uniformity, low glare, reduction of spill light onto surrounding property, and easier maintenance than on higher poles. For point source, flooding light-type fixtures (incandescent or H.I.D.), 35 to 40 foot steel, aluminum (coated to reduce glare), or concrete poles are frequently used. Fluorescent luminaries should be mounted from 13 to 26 feet above the court surface, outside and parallel to the alley lines.

All poles should be designed to withstand wind velocities as required by local codes.
More attention is being given to local laws pertaining to zoning and light pollution. Point sources of light must be carefully shielded and aimed to minimize glare and maximize uniformity of light coverage.

Luminaires

Once familiarity has been gained with the qualities of the various light sources, consideration must also be given to luminaries. A luminaire is the fixture which houses the light source and it determines how much light will actually be emitted from the light source, how much protection from the glare will be afforded, how much protection is given the light source, and how efficiently the light will be distributed over the courts. As with light sources, the actual selection of luminaires should be left to the consultant.

Wiring

Underground wiring is recommended outside the court area. All wiring must comply with the National Electrical Code or applicable local electrical and building codes. Consult these codes or an electrical engineer for wiring requirements and wire sizes.

Centralized switching, remote or courtside metres are available for different light sources. These

options may be investigated for more convenient and efficient control to satisfy project requirements. Consider capacity and conduit for future expansion at slight increase in cost.

Fluorescent, mercury and high pressure sodium lighting are strobic in nature (flickering). To completely eliminate stroboscopic effect, three-phase wiring should be used, with each alternate fixture on a different phase. To avoid losing efficiency, four lamp fluorescent fixtures should be at least 24 inches wide; six- or eight-lamp fixtures should be wider.

Maintenance

All luminaires should be carefully cleaned, as recommended by the manufacturer to obtain maximum efficiency of light output. As much as 50% of the light can be lost if the luminaires are not regularly cleaned and maintained. Consult luminaire manufacturer for maintenance instructions.

SPECIAL NOTE: It is highly desirable to utilize the services of an engineer, architect, or qualified tennis consultant who is completely familiar with tennis court lighting in order to best satisfy the tennis player and take into consideration all of the factors outlined above as well as the project conditions.

Costs

In addition to initial costs, maintenance and operating costs should be considered. Initial costs include fixtures, poles, wiring, installation and control equipment; operating and maintenance costs include power expenses, lamp and lens replacement, fixture cleaning and accessibility, and labour costs associated therewith.

Lighting manufacturers, experts in lighting, and associations such as Illuminating Engineering Society provide guidelines for evaluating the costs of various systems. Several of these make available sample cost calculation forms which categorize the different types of costs, and need only to be filled in. Because the initial cost of a lighting system can vary per court, and because operating costs can vary widely as well, it is particularly important to do a cost analysis whenever comparing systems.

On a per court basis, the cost of lighting is highest for lighting a single court; as the number of courts in a battery increases, the cost per court goes down.

Periodic Checking

An essential part of a regular program is a periodic checking of light output with a light metre. In this way, it can be determined if the lights are performing at the intended footcandle level of the design. If not, corrective steps can be taken.

Checking with a light metre can be helpful both in deciding when to update and improve an old installation and in making sure that a new system is performing satisfactorily. Measurements of light should be taken at a consistent height or 36" - 42" above the court surface.

It is most important to find out what kind of maintenance the installation requires, and then to establish a regular program for upkeep. As an inevitable result, the lights will be more efficient and last longer.